Online Communities: A Social Computing Perspective

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Abstract. In recent years, the growth of the Internet has facilitated the rapid emergence of online communities. In this paper, we survey key research issues on online communities from the perspectives of both social science and computing technologies. We also sample several major online community applications, and propose some directions for future research.

Keywords: online community, social computing, social theory, computing technology.

1 Introduction

In the last twenty years, the growth of the Internet has greatly facilitated the rapid emergence of online communities. Community Memory of Berkeley, California, initially started in the mid-1970s, was viewed by many researchers as the first practical online community [1]. The phrase, online community, however, was created only later in Hiltz's book in 1984 [2]. An online community is a group of people interacting in a virtual environment, who have a purpose, are supported by technology, and are guided by norms and policies [3]. In this paper, we extend the scope of 'online community' to refer to people, the technological infrastructure of virtual environments, and what is produced during online interactions.

Whittaker *et al* [4] identified the core characteristics of online communities. Online communities can be viewed as technology-supported groups of people with a shared goal, interest, need, or activity. With intense interactions and strong emotional ties, its members share resources and provide information, support and services to each other in an established context of social conventions, language, and protocols. An online community consists of the technological environment, members and their social activities, and the study of online communities has to synthesize social theories and computing studies.

Doug Schuler and some other researchers published a Special Issue on Social Computing in Communications of the ACM (1994), in which social computing is described as any type of computing application in which software serves as an intermediary or a focus for a social relation [5]. Schuler [1] discovered the potential of community network and took online communities as the center of the social and political architecture. In the more recent study, Wang *et al* [6] continued the research on social computing, and identified online communities as one of the four main applications in social computing.

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The rest of this paper is organized as follows. In Section 2, we introduce the social theories of online communities. Related computing technologies are introduced in Section 3. Through various applications, we discuss various issues related to improving and extending online communities in Section 4. In Section 5, we summarize the paper and propose several future research directions.

2 Social Theories of Online Communities

In September 1998, the first Advanced Research Workshop of the Joint European Commission/National Science Foundation Strategy Group was held in [7]. The group recommended a series of research workshops to enable early identification of key research challenges and opportunities in information technology. Online community is one of the proposed research priorities. The group also stated that theories from sociology, psychology, social psychology, linguistics, communications research, and psychotherapy can help inform research and development in online communities.

2.1 General Theories

Anthropology
Anthropology is the study of human beings by exploring the differences and similarities between people in terms of cultures, societies, etc. As the new culture of human life is driven by information technology, online phenomena share important similarities with other types of human experience and are amenable to relatively conventional anthropological concepts and assumptions [8]. New communicative practices such as those manifested through online communities fit right into the research domain of anthropologists.

For instance, the online game community is a major representative of online communities. One popular example of these games is the World of Warcraft (WOW). Just like in the early days of the human history, there are many communities composed by gamers called guilds [9]. Researchers have found that a community in the WOW exhibits similar characteristics of a new tribalism [10]. Social fairness in a guild can motivate the gamers to make more contributions. The evolution of online communities in many cases also shares many similarities with the evolution of the human society.

Social Psychology
Hundreds of online communities emerge everyday. Participants of these communities share their experiences, and offer and receive emotional support in a climate of trust, equality, and empathy. Social psychology can also be applied to online community research. Preece and Ghozati [11] found that a community's focus of interest, gender ratio, and hostile or moderate atmosphere can influence a community's empathy. A well designed empathic community will improve the quality of life for many people.

Participation and contributions of individual members are essential to the success of an online community. As such, researchers have paid much attention to member motivation. They found that calling users' attention to their uniqueness and to the benefits they provide have a great impact on increasing their contributions [12]. The participation stimulant is also influenced by offline interaction. Users who perceive greater degree of social presence are more likely to share their information [13].

Social Network Theory
Social connections are a distinct feature of people's interactions. The well-known "six degrees of separation'' phenomenon implies that the distance between any two individuals in terms of direct personal relationships is relatively small. Social network theory examines the patterns and characteristics of social connections and their relationship to individual's lives and societal organization. Social network theory can be used to analyze the online communities from a sociological perspective [14]. Assembling data and benefits for users are two key questions in online social network studies [15]. This area has been drawing much attention due to many new emerging research questions.

Computer-Mediated Communication (CMC) Theory
Compared to face-to-face (FTF) communication, CMC is a more egalitarian medium, with greater equality of participation, relatively less intense normative pressures, and higher incidence of uninhibited behavior [16]. Increasingly, CMC technologies are being used to solve a wide range of problems and have been tapping into the Internet to as a technological platform and an operating environment [17]. CMC provides one of the underlying theories for the study of online communities and from a practical perspective, advances made in CMC could directly lead to new activities and models of online communities.

Sociolinguistics Theory
Linguisticians predicted that online interaction would have a long-term effect on the evolution of language. Development of an online community can bring about changes in linguistic interaction patterns. These patterns could converge as the members of this community converge on a linguistic style [18]. "In the Internet, nobody knows you are a dog." (However, in a recent study, based on sociolinguistics theory, men and women can be identified [19].) Combined with the social network analysis, sociolinguistic research on the online interaction holds a lot of potentials.

In an online community, the members' behavior is multifarious, such as communicating with each other, organizing small groups, constituting rules and custom, using special but uniform language, sharing their information and experience. Such phenomena are quite similar to what we usually do in real life, making existing social theories a proper analysis tool for investigation purposes. In the meanwhile, online communities provide a great test bed to verify these social theories. There exist, however, phenomena that seem to be unique to online communities. Such phenomena present great research opportunities and may lead to theoretical contributions that would enrich the understanding of human societies in general. The next subsection summarizes several prominent social phenomena identified from online communities.

2.2 Social Phenomena Specific to Online Communities

Lurkers
A lurker is a person who reads discussions on a message board, newsgroup, chatroom, file sharing or other online environments, but rarely participates [20]. It is reported that about 90% members of online communities are lurkers. Lurking is a common

activity in online life. Preece and Nonnecke have written a series of papers on lurkers online [21] [22] [23]. They believe that lurking is a systematic and idiosyncratic process, with well-developed rationales and strategies. The top 5 reasons for lurking are as follow [24],

- Shy about posting
- Want to remain anonymous
- Join wrong group
- Fear of being treated poorly
- Poor quality interaction

Lurkers have something in common: frequent login without posting, remaining on standby, posting collected information in order to eliminate the fear of posting something in error [25]. Lurking is usual behavior of community members. Thus it need not necessarily be viewed as passive participation. Lurkers' seemingly silent participation conveys deeper level of engagement than that of non-lurkers.

Other Empirical Findings

Facebook is popular nowadays, on which users keep their own profiles and friend lists. Researchers found that populating profile fields on Facebook is positively related to the number of friends a user lists [26]. There is a tendency of members to join online communities as a target, who seeks support, help and sympathy. However, a recent study showed that online people very rarely ask for help and support directly [27]. There is another interesting finding that users rate fairly consistently across rating scales and tend to rate toward the prediction the system shows, whether the prediction is accurate or not [28]. In other words, users' mind and choices could be manipulated. In addition, many online communities such as forums provide anonymity option for users. Anonymity policies can have a significant effect on the professionalism and productiveness of comments posted in an online community. In an experiment, researchers found that eliminating anonymity option nearly eliminated negative comments [29].

More in-depth work is needed to explore these online community-specific phenomena. Nonetheless, the emerging literature already contains many interesting findings based on social theories. In addition to social phenomena, computing technologies are an essential part of online communities. In the next section, we discuss related research from a computational angle.

3 Computational Studies of Online Communities

The Internet is extending the types of networked communities that have already become prevalent [30]. Many communities have moved from the real world to the virtual environment, from offline to online. Computing technologies play a key role in this transition. In this section, we discuss two lines of computational studies of online communities: community mining and computing community characteristics.

3.1 Community Mining

Although many online communities can be easily identified, there are online communities that are inconspicuous or even hidden. To find them in the huge amount of data on the Internet, researchers have developed a range of computing techniques such as searching, web crawling, social network analysis and data mining. In the context of online community, these techniques are referred to as community mining.

Web Crawling
Unlike the traditional methods such as search or resource-gathering algorithms that find information on a specified topic, Kumar *et al*. [31] proposed a novel method called Web crawl, which helps to identify all instances of graph structures that are indicative signatures of communities. A community on the web is defined as a set of sites that have more links to members than to non-members, which can be efficiently calculated in a maximum flow framework. Under this concept, a maximum flow-based web crawler can approximate a community by directing a focused web crawler along link paths that are highly relevant [32]. Besides the formal communities, the self-organization link structure communities are more complex. A novel method was developed by Flake *et al* [33]. Since this method does not make use of any text-based approaches, identified communities can be used to infer meaningful text rules and to augment text-based methods.

Community Network Analysis
There are various communities in different forms. However, at the heart of each community lies a social network. Applying social network analysis in community mining presents interesting opportunities. Most of the traditional methods on community mining assume that there is only one kind of relation in the network, and the mining results are independent of the users' needs or preferences. Cai *et al*'s [34] approach to social network analysis and community mining represents a major shift in methodology from the traditional ones, a shift from single-network, user-independent analysis to multi-network, user-dependant and query-based analysis. In addition, Yang *et al* [35] have developed a new algorithm to compute signed social networks that contain both positive and negative relations.

Communities in Blogs
A blog is written by a single author and uniquely identified by that person. Thus, a blog functions as an amalgam of document and person, and blogs link hypertext networks with social networks. The novel blogging software is reshaping the online community. Mining virtual communities in blogs is a new branch in community mining [36].

3.2 Computing Community Characteristics

When a person joins an online community, he or she may be involved in a number of activities such as learning about the community structure, searching for information, finding friends with similar hobbies, asking experts and leaders in the community, etc. Computational methods can help characterize such community activities.

Role Identification
Every member plays a role in a community. Some of them are the leaders and experts who are the main information providers at the core of community. Users turn to them for help. Researchers have been developing methods to identify these leaders and experts automatically. A set of network-based ranking algorithms have been proposed, including PageRank and HITS, to identify users with high expertise [37]. It is found that, structural information can be used for evaluating an expertise network in an online setting, and relative expertise can be automatically determined using social network based algorithms. In another study, the novel approach to combining weighting with social computing helped identify key members at a deeper level in Usenet groups [38].

Relationship (trust) Finding
Tens of millions of users participate in Web-based social networking. Privacy and trust are becoming prominent topics for research on online interactions. For example, if Alice highly trusts Bob, and Bob highly trusts Chris, can we recommend that Alice should have some level of trust for Chris? Early research on the topic of trust has focused largely on digital signatures, certificates, and authentication. Golbeck *et al* [39] suggested integrating social network analysis and other traditional methods to create a trust network. She then presented two sets of algorithms for calculating these trust inferences [40].

Information Sharing
Information and communication technologies (ICTs) are dramatically enhancing our ability to collect, organize, and share information. In a recent study, a new approach has been proposed, which allows a group of like-minded people to share documents in an implicit and intelligent way. The approach can facilitate the document recommendation and avoid broadcasting requests so as to protect users' privacy [41]. Wikipedia is a famous open community on the Internet. Users in the community can easily edit, review and publish articles collaboratively. Researchers have developed two models, namely basic model and peer review model, to measure the quality of the articles and the authorities of their contributors [42]. These methods can help the users easily find out valuable information without reading entries one by one.

In summary, computing technologies play a key role in online communities' development and growth, while social theories provide useful guidance and characterization. Synthesizing them properly is essential to the study of online communities.

4 Applications of Online Communities

Various kinds of communities have been developed to meet people's needs for communication and information sharing all over the world. Hiltz and Wellman have predicted that the development of CMC would make virtual communities replace the real ones and connect more people geographically dispersed [43]. The end results are part of the continuing social transformation toward global connectivity. Online communities actually make the world flat.

4.1 Community Evaluation and Improvement

The community members and the platform are the two important constitutional elements of an online community. To build an online community, a thorough understanding of an audience's distinctive demographic, psycho-demographic, and Internet experience characteristics are critical to crafting solutions helping to build sustainable online communities [44].

In recent years, social networking services (SNS) are becoming quite popular. SNSs provide an online private space for individuals and tools for people to interact with others in the cyberspace. Ahn *et al* [45] compared the structures and features of three popular online social networking services: Cyworld, MySpace, and orkut. The results show that online networks are quite similar to the real social networks. Fu *et al* [46] performed an empirical analysis of two Chinese online social networks—Sina blogging network and Xiaonei network (SNS). They found that the blogging network shows the disassortative mixing pattern, whereas the SNS network displays an assortative one.

Online professional communities such as open source software (OSS) communities have flourished in conjunction with the rise of the Web. A major problem for online professional communities is that it is difficult for their members to find the vast amount of information as well as other members' activities. Semantic Web technologies can make unstructured or semi-structured Web information meaningful [47]. The ontology of creating and maintaining a Semantic Web requires one to reliably predict how other members of the community would interpret the symbols of an ontology based on their limited description. Mika's study [48] extended the traditional bipartite model of ontology with the social dimension, leading to a tripartite model of actors, concepts and instances. With more content and more advantages, online communities based on the Semantic Web will possibly replace the more traditional ones.

4.2 Online Commerce

By providing customers with the opportunity to interact with each other and with companies, online communities can foster meaningful customer relationships by customizing products and services to meet consumers' demands and interests [49], so as to, for example, help companies increase the brand loyalty. Online communities' potentials in E-commerce include three main aspects: the building of trust, the collection and effective use of community knowledge and the economic impacts of accumulated buying power [50] [51]. By increasing community commitment, companies can improve their financial performance through consumer rephrasing and word-of-mouth marketing. Online communities have the potential of becoming a strong social structure that promotes trust building and facilitates the growth of electronic commerce.

4.3 Mobile Online Communities

Online communities are being developed through mobile technologies such as PDA, Pocket PC and mobile phones. Coupled with the rapid uptake of mobile phone technology in the developing world and the growing popularity of Internet-based

SNS, social networking applications developed for mobile phones could leverage both existing technology usage patterns and information seeking patterns in the developing world. This is reflected in the new word 'MoSoSo' (Mobile Social Software) [52]. Researchers have also experimented a messaging application for camera phones to collectively create stories called Media Stories with the idea of collectively created albums [53]. Using this kind of system, people can exchange information more quickly. A new fully-distributed mobile portfolio improves the flexibility to conduct interactions or share portfolio resources among the members of a community [54]. This distributed portfolio is expected to help team members interact, and exchange resources and experiences.

4.4 Other Emerging Applications

There is a notable phenomenon that the female are underrepresented in the areas of STEM (Science, Technology, Engineering, and Mathematics). Researchers from Germany created an online community and e-mentoring program called CyberMentor for German high school girls and women to encourage them to engage in STEM vocational fields [55].

Online community is viewed as a more conducive organizational form to human-centric computing than traditional business organizations [56]. In previous online communities, the discovery of people with the same interests or a similar context was accomplished manually by the users themselves. Recently, researchers have designed a framework for user-centric community platforms to support flexible and adaptive management of user communities [57].

5 Conclusion and Future Work

Along with the wide adoption of Web 2.0 technologies, online communities are expected to continue to grow. As a research area, online communities are increasingly attracting attention of researchers from both social sciences and computing technologies. From a sociological point of view, social theories are widely used to analyze the characteristics in online communities. On the other hand, some online phenomena can not be explained using current social theories, and thus new creative theories are needed. From a computing technologies viewpoint, researchers are focusing on techniques for mining the community and computing community characteristics. Community mining aims to find hidden communities and synthesize various computing techniques. Computing community characteristics help users understand a community and accomplish their goals.

As is shown in this paper, online communities are flourishing both in research and in practice. However, much work still remains for social computing researchers and developers. Some future directions that deserve greater attention include but not limited to the follows:

- Utilize fruitful results in social studies to improve the community experience;
- Propose new social theories or modify existed ones to explain the emergent phenomena in online communities;
- Explore the structure and formation mechanism of online communities;

- Develop novel algorithms for mining community and computing community characteristics;
- Enhance self-organization and self-management of community, and the adaptability of community building platforms to other devices especially mobile devices;
- Automate information and knowledge sharing, and expand the scope of online community applications.

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